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मानक

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Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

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“पुराने को छोड़ नये के तरफ”

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IS/QC 960000 (1995): Electromechanical Switches for Use in Electronic Equipment, Part 1: Generic Specification [LITD 3: Electromechanical COmponents and Mechanical Structures for Electronic Equipment]



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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

इलैक्ट्रॉनी उपस्कर में उपयोग के लिये विद्युत यांत्रिक स्विच
भाग 1 विशिष्टि

Indian Standard

ELECTROMECHANICAL SWITCHES FOR USE IN
ELECTRONIC EQUIPMENT

PART 1 GENERIC SPECIFICATION

UDC 621.316.542 : 621.38.038

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NEW DELHI 110002

NATIONAL FOREWORD

This Indian Standard, which is identical with IEC Pub 1020-1/QC 960000 (1991-04) 'Electromechanical switches for use in electronic equipment, Part 1 : Generic specification', issued by the International Electrotechnical Commission, was adopted by Bureau of Indian Standards on the recommendation of Electromechanical Components for Electronic Equipment Sectional Committee and approval of the Electronics and Telecommunication Division Council.

The text of the IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

| <i>International Standards</i> | <i>Corresponding Indian Standard</i> | <i>Degree of Equivalence</i> |
|--|--|------------------------------|
| IEC Pub 512-2 (1985) Electromechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 2 : General examination, electrical continuity and contact resistance tests and voltage stress tests | IS 12448 (Part 2/Sec 1 to 4): 1988 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 2 General examination, electrical continuity and contact resistance tests and voltage stress tests Section 1 General requirements Section 2 Electrical continuity and contact resistance tests Section 3 Insulation tests Section 4 Voltage stress tests | Equivalent |
| IEC Pub 512-3 (1976) Electromechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 3 : Current-carrying capacity tests | IS 12448 (Part 3): 1989 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 3 Current-carrying capacity tests | Equivalent |
| IEC Pub 512-4 (1976) Electro-mechanical components for electronic equipment : Basic testing procedures and measuring methods. Part 4 : Dynamic stress tests | IS 12448 (Part 4): 1989 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 4 Dynamic stress tests | Equivalent |
| IEC Pub 512-5 (1977) Electro-mechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 5 : Impact tests (free components), static load tests (fixed components) endurance tests and over load tests | IS 12448 (Part 5/Sec 1 to 4): 1989 Basic testing procedures and measuring methods for electro-mechanical components for electronic equipment: Part 5 Impact tests (free components), static load tests (fixed components) endurance tests and over load tests Section 1 Impact test Section 2 Static load test (fixed components) Section 3 Endurance tests Section 4 Overload tests | Equivalent |

(Continued on third cover)

Indian Standard

ELECTROMECHANICAL SWITCHES FOR USE IN ELECTRONIC EQUIPMENT

PART 1 GENERIC SPECIFICATION

1. Scope and object

1.1 *Scope*

This generic specification is applicable to electromechanical switches of assessed quality in accordance with the IEC Quality Assessment System for Electronic Components (IECQ).

Switches covered by this specification:

- a) are devices which open, close, or change the connection of a circuit by the mechanical motion of conducting parts (contacts);
- b) have a maximum rated voltage of 500 V;
- c) have a maximum rated current of 63 A;
- d) are intended for use in electronic equipment or similar uses.

This generic specification does not include keyboards and keypads which are intended for use in information-handling systems. Electromechanical key switches may be included within the scope of this generic specification.

Switch families shall be described in sectional specifications that make reference to this generic specification. Blank detail specifications, from which detail specifications may be developed by filling in the relevant performance data, make reference to the applicable sectional specifications. In lieu of blank detail specifications, the sectional specification may provide instructions for the preparation of detail specifications.

1.2 *Object*

The object of this generic specification is to establish a uniform quality assessment system and to provide consistency in sectional specifications for electromechanical switches by specifying the terminology, symbols, test methods and other necessary information.

SECTION 2 — GENERAL

2. General

2.1 *Related publications*

The following publications form a part of this specification to the extent specified herein. When a specific edition is not given, the latest edition of the publication shall be used.

| | |
|---------------------|--|
| IEC 27: | Letter symbols to be used in electrical technology. |
| IEC 50(581): | International Electrotechnical Vocabulary, Chapter 581: Electro-mechanical components for electronic equipment. |
| IEC 62: | Marking codes for resistors and capacitors. |
| IEC 65: | Safety requirements for mains operated electronic and related apparatus for household and similar general use. |
| IEC 68: | Environmental testing. |
| IEC 68-1 (1983): | Part 1: General and guidance. |
| IEC 68-2-17 (1978): | Part 2: Test Q: Sealing. |
| IEC 68-2-20 (1979): | Test T: Soldering. |
| IEC 68-2-21 (1983): | Test U: Robustness of terminations and integral mounting devices. |
| IEC 68-2-38 (1974): | Test Z/AD: Composite temperature/humidity cyclic test. |
| IEC 68-2-45 (1980): | Test XA and guidance: Immersion in cleaning solvents. |
| IEC 410 (1973): | Sampling plans and procedures for inspection by attributes. |
| IEC 512: | Electromechanical components for electronic equipment; basic testing procedures and measuring methods. |
| IEC 512-2 (1985): | Part 2: General examination, electrical continuity and contact resistance tests and voltage stress tests. |
| IEC 512-3 (1976): | Part 3: Current-carrying capacity tests. |
| IEC 512-4 (1976): | Part 4: Dynamic stress tests. |
| IEC 512-5 (1977): | Part 5: Impact tests (free components), static load tests (fixed components), endurance tests and overload tests. |
| IEC 512-6 (1984): | Part 6: Climatic tests and soldering tests. |
| IEC 512-7 (1978): | Part 7: Mechanical operating tests and sealing tests. Amendment No. 1 (1983). |
| IEC 512-8 (1984): | Part 8: Connector tests (mechanical) and mechanical tests on contacts and terminations. Amendment No. 1 (1985). |

| | |
|-------------------|--|
| IEC 512-9 (1977): | Part 9: Cable-clamping tests, explosion hazard tests, chemical resistance tests, fire hazard tests, r.f. resistance tests, capacitance tests, shielding and filtering tests and magnetic interference tests. Amendment No. 1 (1982). |
| IEC 617: | Graphical symbols for diagrams. |
| IEC 664: | Insulation co-ordination within low-voltage systems including clearances and creepage distances for equipment. |
| IEC 664A: | First supplement. |
| IEC 707 (1981): | Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source. |
| IECQ QC 001001: | Basic rules of the IEC Quality Assessment System for Electronic Components (IECQ). |
| IECQ QC 001002: | Rules of procedure of the IEC Quality Assessment System for Electronic Components (IECQ). |
| ISO 129: | Technical drawings — Dimensioning — General principles, definitions, methods of execution and special indications. |
| ISO 286-1: | ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits. |
| ISO 1000: | SI units and recommendations for the use of their multiples and of certain other units. |
| ISO 1101: | Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings. |

2.2 *Units and symbols*

Units, graphical symbols and letter symbols shall be, whenever possible, in accordance with ISO 1000, IEC 27 and IEC 617.

Graphical symbols and letter symbols peculiar to a particular switch subfamily shall be defined in the applicable sectional specification. Graphical symbols and letter symbols peculiar to a group of structurally similar switches shall be defined in the detail specification. When additional units or symbols are required, they shall be derived in accordance with the principles of the documents listed above whenever possible.

2.3 *Terminology*

Terminology shall be in accordance with IEC 50(581).

Terminology peculiar to a particular switch subfamily shall be defined in the applicable sectional specification. Terminology peculiar to a group of structurally similar switches shall be defined in the detail specification.

The following terminology is common to all electromechanical switches. Where the definition is compatible with an established definition listed in IEC 50(00), the IEV number for the related definition is given in brackets.

Basic insulation: The insulation necessary for the proper functioning of the switch by providing basic protection against electrical breakdown.

Category temperature range: The range of ambient temperatures for which the switch has been designed to operate continuously.

Clearance: The shortest distance in air between two conductive parts. [IEC 664]

Contact bounce: The intermittent and random opening of closed contacts and closing of open contacts which may occur after contact transfer and which is caused by the switch mechanism.

Contact bounce time: The time period measured from the moment of first closure of two mating contacts or first opening of two closed contacts to the moment when all contact bounce ceases.

Contact disturbance: The intermittent and random closing of open contacts and/or opening of closed contacts caused by external influences such as shock and vibration.

Contact separation (gap): The distance between mating contacts when the contacts are open.

Contact set: A group of contacts which all function in relation to the same pole of a switch.

Creepage distance: The shortest distance along the surface of an insulating material between two conductive parts. [IEC 664]

Cycle (operation): The actuation or actuations necessary to close (or open) a set of contacts and return the contacts to their original mode. [IEV 441-16-02]

Double break switch: A switch that opens a circuit at two points in series with each other.

Double insulation: Insulation which consists of basic insulation and supplemental insulation with the two insulations physically separated.

Double pole: A term applied to a contact arrangement to denote that it includes two separate forms; that is, two single pole contact assemblies.

Double throw: A term applied to a contact arrangement to denote that each contact form included is a break-make.

Duty cycle: The ratio of conducting (ON) time to the total time for one cycle. For example 30% ON. [IEV 151-04-06]

Electromechanical switch: A switch that opens, closes, or changes the connection of an electrical circuit by the mechanical motion of conducting parts (contacts).

Lower category temperature: The minimum ambient temperature for which a switch has been designed to operate continuously.

Pole (switch): That portion of the switch associated exclusively with one electrically separated conducting path of the main circuit of the device. [IEV 441-15-01]

NOTES — 1 Those portions that provide a means for mounting and operating all poles together are excluded from the definition of a pole.

2 A switching device is called single pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided that the poles are coupled in such manner as to operate together.

Opposite polarity: Two parts of a switch which when connected together may result in blowing the line fuses to the power supply.

Single pole: A term applied to a contact arrangement to denote that it includes only one circuit.

Single throw: A term applied to a contact arrangement to denote that each contact form included is a single contact pair.

Snap-action: The type of switching action in which the speed of the moving contact is relatively independent of the speed of the actuating mechanism.

Style: A sub-division of a type generally based on dimensional factors. A style may include several variants, generally of a mechanical order.

Supplementary insulation: An independent insulation provided in addition to basic insulation to provide protection against electric shock in the event of a failure of the basic insulation.

Type: A group of switches having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection.

They are generally covered by a single detail specification; however, switches described in several detail specifications may, in some cases, be considered as belonging to the same type and may be grouped together for approval and quality conformance inspection.

Upper category temperature: The maximum ambient temperature for which a switch has been designed to operate continuously.

Wiping action (contact): The sliding or tangential motion between two contact surfaces when they are touching.

2.4 Preferred values

The sectional or blank detail specification may prescribe any preferred values for rated and limiting values, characteristics, tolerances, requirements and dimensions applicable to the whole subfamily.

2.4.1 Clearance and creepage distances

The sectional or detail specification shall specify either the minimum clearance and creepage distances or the minimum dielectric test voltage under specified air pressure for either basic or double insulation, as applicable. When minimum clearance and creepage distances are specified, the applicable material group of IEC 664 shall also be specified for the insulating materials of the switch.

2.5 Marking

Where space permits after national or contractual marking requirements (for example, safety requirements) have been satisfied, each switch shall be marked with the following information:

- a) terminal identification when specified by the relevant specification;
- b) date code: the date code shall be in accordance with IEC 62;
- c) manufacturer's name or trade mark;
- d) IEC part number identification (number of detail specification plus the number for the style of the switch).

Other markings may be applied to the switches provided they do not obscure or confuse the required markings. When conditions do not permit full marking on the switch, the markings shall be applied in the order of preference shown above. Any required marking that cannot be applied to the switch shall be marked on the package containing the switch.

SECTION 3 — QUALITY ASSESSMENT PROCEDURES

3. Quality assessment procedures

When this specification is used within the IEC Quality Assessment System for Electronic Components (IEC Q System), the basic rules and rules of procedure for the quality assessment system shall be in accordance with IEC QC 001001 and QC 001002, respectively.

3.1 *Qualification approval/Quality assessment systems*

3.1.1 When these documents are being used for the purpose of a full quality assessment system such as the IEC Quality Assessment System for Electronic Components (IEC Q), with qualification approval and quality conformance inspection, the procedures of 3.4 and 3.5 shall be complied with.

3.1.2 When these documents are used outside such quality assessment systems as the IEC Q system for purposes such as design proving or type testing, the procedures and requirements of 3.4.1 and 3.4.2 may be used, but the tests and parts of tests shall be applied in the order given in the test schedules.

3.2 *Primary stage of manufacture*

The primary stage of manufacture is defined as the process which produces a piece part which can be identified with the switch.

3.3 *Structurally similar switches*

Switches may be considered to be structurally similar and may be grouped for the purpose of forming inspection lots provided the following conditions are met:

- the switches shall be produced by the manufacturer using essentially the same design, materials, processes and methods;
- the switches shall be such that the results of a given test carried out on one switch design are valid for other switch designs in the group;
- each design variant defined in the detail specification shall be assigned a unique part number by the manufacturer;
- the manufacturer shall submit to the National Supervising Inspectorate a statement of the structural similarities between the switch designs for which qualification approval is sought;
- the National Supervising Inspectorate shall approve the grouping of structurally similar switches;
- additional conditions which may be specified by the relevant sectional specification are met.

When switches are grouped for inspection purposes, the test limits applicable to each individual switch design shall still apply, and a failure of the test samples to meet the specified requirements shall be cause for the rejection of all the production lots from which the sampling was made.

3.4 *Qualification approval procedures*

3.4.1 The manufacturer shall comply with:

- the general requirements of the rules of procedure governing qualification approval;
- the requirements for the primary stage of manufacture contained in 3.2.

3.4.2 The tests required for qualification approval inspection shall be specified in the sectional specification.

The test samples for qualification approval inspection shall be randomly selected from a current production lot or as agreed with the National Supervising Inspectorate.

In the event that qualification is sought on a variant of a previously qualified switch, qualification inspection shall be limited to those tests for which the test results on the previously qualified switch are not valid.

3.4.2.1 The minimum number of test specimens for each test shall be specified in the sectional specification. The test specimens shall be representative of the type(s) for which qualification is sought (see 3.3). Test specimens shall not be included in lots released for delivery.

3.4.2.2 Qualification approval may be granted for all switches which are structurally similar (see 3.3) to the qualification test specimens.

3.4.3 Qualification approval which is obtained as part of a quality assessment system shall be maintained by regular demonstration of compliance with the requirements for quality conformance inspection. Qualification approval without quality conformance must be verified by the rules for maintenance of qualification approval given in 11.5.2 and 11.5.3 of IEC QC 001002.

3.5 *Quality conformance inspection*

The detail specification associated with the sectional specification shall prescribe the test schedule for quality conformance inspection. This schedule may also prescribe the grouping (formation of inspection lots), sampling and periodicity (period over which production lots may be grouped) for lot-by-lot and periodic inspection. Inspection levels and AQL's shall be specified by the detail specification and shall be selected from those given in IEC 410. If necessary, more than one schedule may be specified.

3.5.1 *Certified records of released lots*

When the relevant specification specifies the issuance of a certified record of released lots, it shall prescribe the tests for which the results shall be presented and shall specify how these results shall be expressed. As a minimum, these records shall contain attributes information (i.e. number of components tested and number of defective components) for tests in the subgroups covered by periodic inspection without reference to the parameters for which rejection was made.

3.5.2 *Delayed delivery*

Switches held for more than three years (unless otherwise specified by the relevant specification) following the release of the inspection lot shall be re-examined prior to delivery. The tests required for re-examination shall be specified in the sectional specification. The procedure of the re-examination shall be approved by the National Supervising Inspectorate. Once a lot has been re-inspected, the quality assessment is renewed for the specified period.

Switches with solderable terminals which are held more than one year following the release of the inspection lot shall be re-examined for solderability prior to delivery. The procedure for the re-examination shall be approved by the National Supervising Inspectorate. Once a lot has been re-examined for solderability, the quality assessment is renewed for one more year.

3.5.3 *Release of lots for delivery*

The lots shall be released or rejected on the basis of the lot-by-lot tests unless otherwise prescribed in the relevant specification.

3.5.4 *Delivery of tested switches*

Only switches subjected to non-destructive tests may be included in the lot to be delivered. Switches subjected to destructive tests shall not be included in the lot to be delivered. Destructive tests shall be defined in the sectional specification.

3.5.5 *Lot-by-lot inspection tests*

The minimum requirements for lot-by-lot inspection shall be prescribed in the sectional specification. In-process testing shall be permitted under the conditions specified in 12.3.4 of IEC QC 001002.

NOTE — Further consideration is required for special cases where the small lot size affects the statistical requirements for the sample sizes.

3.5.6 *Periodic inspection tests*

The tests required for periodic inspection shall be prescribed by the sectional specification. The periodic inspection shall be performed at intervals no greater than 36 months.

3.6 *Alternative test methods*

The test and measurement methods prescribed herein are not necessarily the only methods which can be used. For alternative test methods not specified herein, the manufacturer shall satisfy the National Supervising Inspectorate that any alternative methods used will produce results equivalent to those obtained by the specified methods. In case of dispute, the specified methods shall be used for referee or reference purposes.

3.7 *Unchecked parameters*

Only those parameters of a switch which have been specified in a detail specification and which were subject to testing can be assumed to be within the specified limits. It should not be assumed that any parameters not specified will remain unchanged from one switch to another. Should it be necessary for any reason for further parameter(s) to be controlled, then a new, more extensive, specification should be used. The additional test method(s) shall be fully described and appropriate limits, AQL's and inspection levels specified.

SECTION 4 — TEST AND MEASUREMENT PROCEDURES

4. **Test and measurement procedures**

4.1 *General*

The sectional and/or detail specification shall contain tables showing the tests to be made, the measurements to be made before and after each test or group of tests, and the sequence in which they shall be carried out. The measuring conditions shall be the same for initial and final measurements. When tests are performed in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

If national specifications within any quality assessment system include test methods other than those specified in the above publications, the test methods shall be fully described.

Not all the test methods prescribed herein are applicable to all types and styles of switches. The relevant specification shall prescribe the test methods which are applicable for that switch type.

When necessary, additional test methods and/or details of the test methods shall be prescribed by the relevant specification.

4.1.1 *Electrical tolerances*

Unless otherwise specified, the actual value of the test voltage, test current and test frequency shall be within 5% of the specified electrical ratings for the switch.

4.1.2 *Preconditioning*

Unless specified by the test method, the switches shall not be subjected to any special preparations, such as cleaning, prior to or during the tests.

4.1.3 *Mounting*

When mounting is prescribed by the test method, the switch shall be rigidly mounted by its normal mounting means and connected as specified in the detail specification. The method of mounting and the materials used for mounting shall not adversely affect the electrical or mechanical performance of the switch.

4.1.4 *Order of precedence*

The order of precedence for limits applicable to any required test method shall be:

- a) detail specification;
- b) sectional specification;
- c) generic specification;
- d) basic specification.

4.1.5 *Optional reduction of testing*

Where prescribed by the sectional specification, the total number of contact sets to be tested may be reduced according to the conditions prescribed by the sectional specification.

4.2 *Standard atmospheric conditions*

The standard atmospheric conditions shall be in accordance with Clause 5 of IEC 68-1.

4.3 *General examination*

4.3.1 *Visual examination*

Method: the examination shall be performed in accordance with IEC 512-2, Test 1a. The following features shall be examined without magnification:

- a) markings (2.5);
- b) general appearance;
- c) workmanship.

Requirement: the markings shall be correct and legible. The switch shall be manufactured in a careful and workmanlike manner.

4.3.2 *Dimensions*

Method: the measurements shall be performed in accordance with IEC 512-2, Test 1b. The following details shall apply:

- a) the specified outline dimensions, detailed dimensions, clearances and creepage distances shall be measured;
- b) the accuracy and resolution of the measuring equipment (micrometers, calipers, visual comparators, etc.) shall be commensurate with the dimensions being measured.

Requirement: the dimensions shall be within the limits specified by the relevant specification.

4.3.3 *Dimensions, gauging*

Method: the examination shall be performed in accordance with IEC 512-2, Test 1b. The dimensions prescribed by the detail specifications as being suitable for gauging shall be checked using the gauges or gauge dimensions specified by the relevant specification.

Requirements: the switch shall comply with the prescribed gauging.

4.3.4 *Mass*

Method: the measurement shall be performed in accordance with IEC 512-2, Test 1b. The following details shall apply:

- a) the accuracy and resolution of the measuring equipment shall be commensurate with the mass being measured;
- b) the measurement shall include all removable parts (mounting hardware, etc.) prescribed by the relevant specification.

Requirement: the mass shall be within the limits specified by the relevant specification.

4.3.5 *Functional operation*

Object: to assess the proper functioning of all switching operations.

Method: for coded switches, each switching circuit shall be connected to a monitoring circuit which has a maximum current of 150 mA and provides an indication of current flow. With the exception of coded switches, the test facility may use the contact resistance test to check the switching circuit.

The correct functioning of all mechanical detents, latching, locking, interlocking and self-return mechanisms shall be checked.

The correct functioning of all electrical non-switching operations, such as lamp circuits or solenoids, shall be checked at their rated voltage or rated current.

Requirement: the functional operation of the switch, including the sequence of contact operations, shall comply with the requirements specified by the relevant specification.

4.3.6 *Operating characteristics*

Object: to assess the force and travel characteristics of the switch actuator.

Method: operating force shall be measured in accordance with IEC 512-7, Test 13c. Operating torque shall be measured in accordance with IEC 512-7, Test 13d. The method for measuring other mechanical operating characteristics shall be specified by the relevant specification.

The method for measuring other operating characteristics such as temperature, air pressure, etc., shall be specified by the relevant specification.

Requirement: the operating characteristics shall be within the limits specified by the relevant specification.

4.3.7 *Contact bounce*

Object: to determine the duration of the intermittent and random opening of closed contacts and closing of open contacts which may occur after contact transfer and which is caused by the switch mechanism. Electronic logic circuits may produce spurious data due to the kinetic behaviour of the switching contacts.

Method: the switch shall be mounted in accordance with 4.1.3.

The test circuit shown in Figure 1, page 31, or an equivalent, shall be used for detecting contact bounce. The values for the d.c. test voltage and test current shall be specified in the relevant specification, but shall not exceed an open circuit voltage of 6 V d.c. and a test current of 100 mA.

The detection and display means (oscilloscope or equivalent) utilized in the circuit shall have a bandwidth of 1 MHz or greater, a minimum time base accuracy of $\pm 5\%$, and shall be capable of showing the quiescent contact state prior to contact transfer.

The switch shall be actuated at a constant velocity at the rate specified in the sectional specification. When the contact bounce is affected by the actuation force, the limits of the force shall be specified in the relevant specification.

The duration of the contact bounce shall be the maximum measurement occurring in five consecutive measurements of contact closure and contact opening. For the purpose of this test, the contacts shall be open when the voltage drop across the contacts is at least 90% of the open circuit voltage. The contacts shall be closed when the voltage drop across the contacts is no greater than 10% of the open circuit voltage. When the contacts are closed, the voltage variations within the 10% limit are due to variations in the dynamic contact resistance. Contact bounce is the time duration measured from the moment of first closure (or opening) to the moment when the contacts remain closed (or opened). See Figure 2, below.

Requirement: the duration of the contact bounce shall be within the limits specified by the relevant specification.

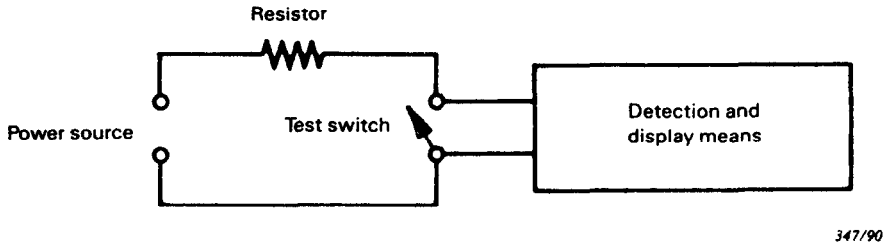


Figure 1 — Contact bounce test circuit

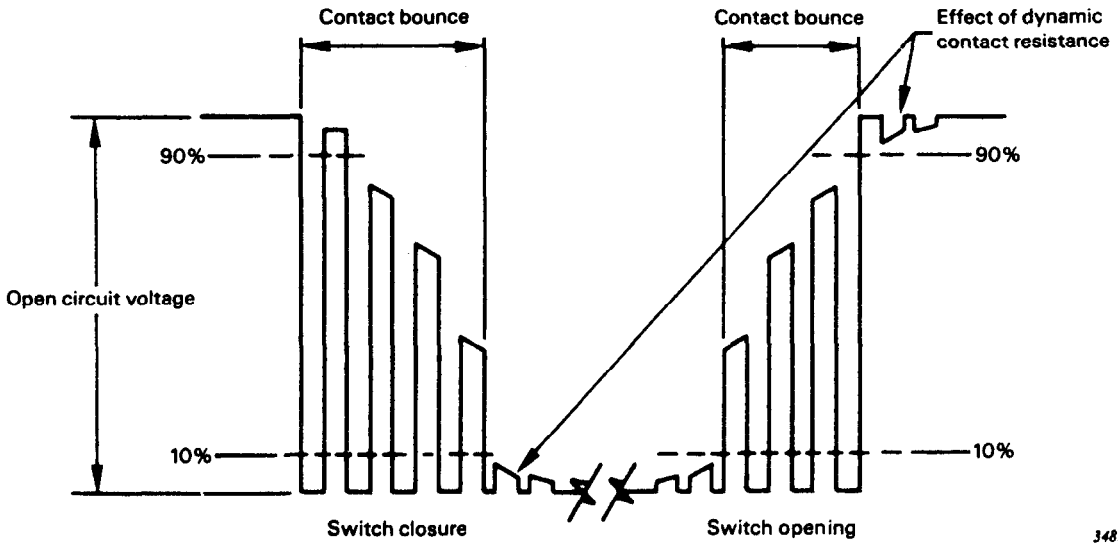


Figure 2 — Typical trace of contact bounce

4.4 Resistance measurements

4.4.1 Contact resistance — Millivolt level

Object: to measure the total electrical resistance of the conducting switching circuits, including the switch terminations, at a voltage which has no electrical effect on the contact material.

Method: the measurement shall be performed in accordance with IEC 512-2, Test 2a. The following details shall apply:

- a) one measuring cycle shall be performed on each switching circuit;
- b) when contact resistance is dependent upon the operating force, the contact resistance shall be measured at the operating force specified by the relevant specification.

Requirement: the contact resistance shall be within the limits specified by the relevant specification.

4.4.2 Contact resistance — Specified current

Object: to measure the total electrical resistance of the conducting switching circuit, including the switch terminations, at a voltage greater than the melting voltage of the contact material.

Method: the measurement shall be performed in accordance with IEC 512-2, Test 2b. The following details shall apply:

- a) one measuring cycle shall be performed on each switching circuit;
- b) when contact resistance is dependent upon the operating force, the contact resistance shall be measured at the operating force specified by the relevant specification.

Requirement: the contact resistance shall be within the limits specified by the relevant specification.

4.4.3 Resistance (earthing) from actuator to mounting bushing (surface)

Object: to measure the total electrical resistance between the conductive portion of the switch actuator and the mounting bushing.

Method: the measurement shall be performed in accordance with IEC 512-2, Test 2h. The following details shall apply:

- a) the voltage drop measurement shall be made between a suitable point on the mounting bushing and the conductive part of the switch actuator (or the shield used for electromagnetic interference, if applicable).

Requirement: the actuator resistance shall be within the limits specified by the relevant specification.

4.4.4 Insulation resistance

Method: the measurement shall be performed in accordance with IEC 512-2, Test 3a. The following details shall apply:

- a) the insulation resistance shall be measured between each terminal and the ground, between terminals of adjacent mutually insulated circuits and between all unconnected terminals of the same switching circuit. At the option of the manufacturer, terminals may be grouped together to reduce the duration of the test. In the event of a failure with the terminals grouped together, each terminal shall be tested individually for acceptance;

- b) the measurement shall be performed in each actuator position up to a maximum of six positions;
- c) the sectional specification may prescribe a reduction of measurements for switches having more than six poles, wafers, or cells and for switches with more than six operating positions.

Requirements: the insulation resistance shall be within the limits specified by the relevant specification.

4.5 *Voltage stress*

4.5.1 *Voltage proof*

Method: the test shall be performed in accordance with IEC 512-2, Test 4a. The following details shall apply:

- a) the points of measurement shall be between live parts which may be of opposite polarity, and between live parts and the ground;
- b) the test voltage shall be specified in the relevant specification;
- c) for lot-by-lot inspection, the duration of the application of the test voltage shall be 5 s minimum or, at the option of the manufacturer, the duration may be reduced to 1 s if the test voltage is increased to 120% of the specified value;
- d) the leakage current shall be measured by any appropriate means;
- e) the test shall be performed in each actuator position.

Requirement: during the test, there shall be no breakdown or flashover. The leakage current shall be within the limits specified by the relevant specification.

4.5.2 *Low air pressure*

Object: to assess the ability of an insulation to resist breakdown when subjected to voltage stress under simulated altitude conditions.

Method: the test shall be performed in accordance with IEC 512-6, Test 11k.

- a) the test shall be performed in a sealed test chamber. The internal air pressure in the chamber shall be maintained at $8 \text{ kPa} \pm 5\%$ (approximately 17 600 m or 58 000 feet of altitude), unless otherwise specified. The chamber shall be suitably equipped with electrical connections through the chamber wall;
- b) unless otherwise specified, the test voltage shall be 400 V a.c. (r.m.s.) for switches with a rated voltage above 42 V.

Requirement: during the test, there shall be no breakdown or flashover. The leakage current shall be within the limits specified by the relevant specification.

4.6 *Temperature rise*

4.6.1 *Temperature rise*

Object: to assess the temperature rise of the switch terminals at rated current.

Method: the measurement shall be performed in accordance with IEC 512-3, Test 5a. The following details shall apply:

- a) the switch shall be mounted on a flat horizontal non-conductive surface;
- b) the temperature sensing device shall be a thermocouple located on the terminal as close as possible to the switch housing;
- c) the contacts to be tested shall be those contacts previously tested for electrical endurance on power rated electrical loads (see 4.10.1). The temperature rise test shall be performed immediately after the electrical endurance test;

- d) the test current shall be the maximum rated current of the switch;
- e) the test duration shall be 1 h. The test may be terminated after three consecutive readings, taken at five minute intervals, indicating no change in temperature greater than 1 °C;
- f) the wire size shall be the same size used for the electrical endurance test and have a minimum length of 300 mm (12 in).

Requirement: the temperature rise shall be 45 °C maximum.

4.7 *Dynamic stress*

4.7.1 *Shock*

Method: the test shall be performed in accordance with IEC 512-4, Test 6c. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means;
- b) unless otherwise specified, the shock pulse shall be a half-sine pulse with a peak acceleration of 490 m/s² (50 g) and with a pulse width of 11 ms;
- c) the shock pulse shall be applied three times in each direction of the three mutually perpendicular axes of the switch for a total of 18 shock pulses;
- d) when specified by the relevant specification, the switch contacts shall be monitored for contact disturbance in accordance with the contact disturbance test (see 4.7.3);
- e) after the test, the switch shall be visually examined for broken, deformed, displaced or loose parts. After the test group sequence, the switch shall be subjected to the functional operation test (see 4.3.5).

Requirement: when specified by the relevant specification, there shall be no closing of open contacts or opening of closed contacts in excess of the value specified by the relevant specification. After the test, there shall be no damage that impairs the electrical or mechanical operation of the switch.

4.7.2 *Vibration*

Method: the test shall be performed in accordance with IEC 512-4, Test 6d. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means;
- b) the frequency range and amplitude shall be specified by the relevant specification;
- c) the duration of the endurance shall be 12 sweep cycles for each axis;
- d) the vibration frequency shall be varied logarithmically between the limits of the frequency range. The entire frequency range shall be swept from the lowest frequency to the highest frequency and returned to the lowest frequency;
- e) when specified by the relevant specification, the switch contacts shall be monitored for contact disturbance in accordance with the contact disturbance test (see 4.7.3);
- f) after the test, the switch shall be visually examined for broken, deformed, displaced or loose parts. After the test group sequence, the switch shall be subjected to the functional operation test (see 4.3.5).

Requirement: when specified by the relevant specification, there shall be no closing of open contacts or opening of closed contacts in excess of the value specified by the relevant specification. After the test, there shall be no damage which impairs the electrical or mechanical operation of the switch.

4.7.3 *Contact disturbance*

Method: the monitoring shall be performed in accordance with IEC 512-2, Test 2e. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means;
- b) the switch shall be continuously monitored for the duration of the dynamic stress tests.

Requirement: the requirement shall be specified by the applicable dynamic stress test method.

4.8 *Mechanical strength*

4.8.1 *Robustness of actuator*

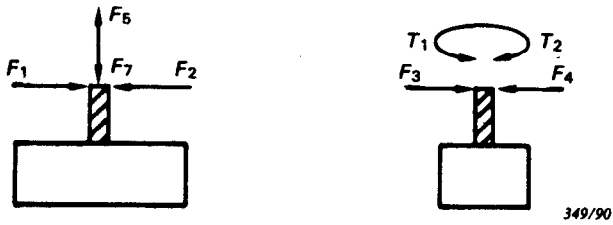
Object: to assess the mechanical strength of the switch actuator using static pressure.

Method: the switch shall be mounted by its normal mounting means. The relevant specification shall specify the force or torque to be applied and the direction in which the force shall be applied. The designation of Figure 3, page 41, shall be used to specify the direction of the applied force.

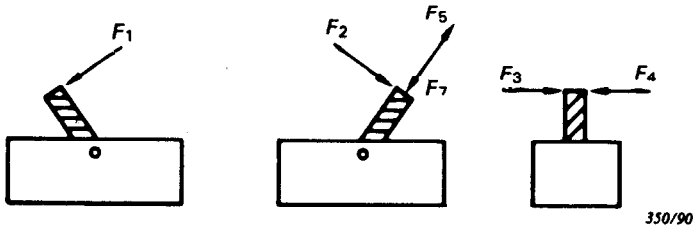
The force or torque shall be steadily increased to the specified value and then maintained for 1 min during qualification approval tests and 10 s for lot acceptance tests. The specified force shall be applied in succession to each switch. If the switch actuators cannot be readily gripped by the fingers, forces F5, F6 and torques T1, T2 may be omitted. If the switch actuator is protected from the directional force, the force may be omitted. For example, F1 and F2 may be omitted for rocker switches which are underflush with the panel.

After the test, the switch shall be visually examined for broken, deformed, displaced or loose parts. After the test group sequence, the switch shall be subject to the functional operation test (see 4.3.5).

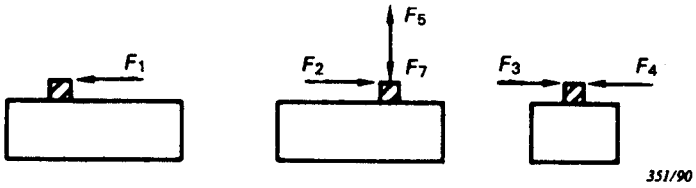
Requirement: after the test, there shall be no damage which impairs the electrical or mechanical operation of the switch.



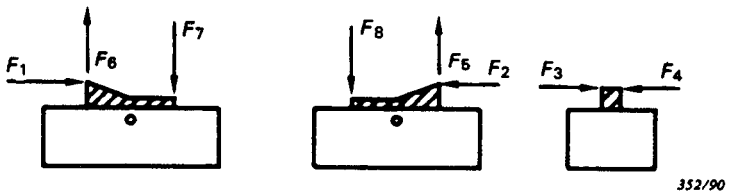
a) Spindle, button, plunger



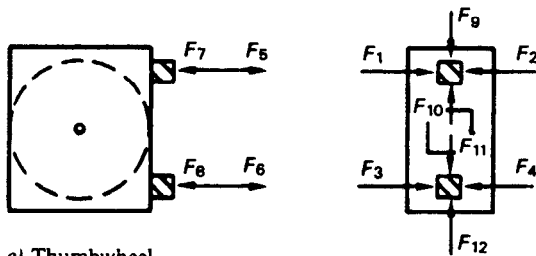
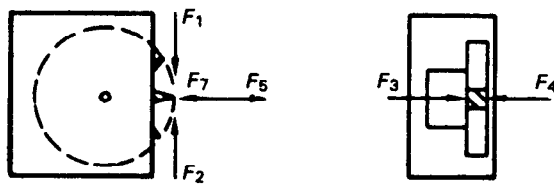
b) Lever



c) Slider



d) Rocker



e) Thumbwheel

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Figure 3 — Application of forces and torques for test 4.8.1

4.8.2 Robustness of mounting bushing

Object: to assess the ability of a switch having a threaded mounting bushing to withstand the forces associated with the normal mounting of the switch.

Method: the switch shall be mounted through an appropriate size hole in a metal plate using its normal mounting means and the specified mounting hardware, if any. The mounting nut shall be tightened with a torque equal to 125% of the mounting torque specified in the relevant specification. The torque shall be maintained for 1 min then loosened. The nut shall be tightened and then loosened a total of five times.

Requirement: after the test, there shall be no mechanical damage which would impair normal switch operation.

4.8.3 Robustness of screw mounting

Object: to assess the ability of a screw-mounted switch to withstand the forces associated with the normal mounting of the switch.

Method: the test shall be performed in accordance with IEC 68-2-21, Test Ud. The following details shall apply:

- a) the test shall be applied to the screws specified for mounting the switch. If no screws are specified, the largest screw that may be used to mount the switch shall be selected;
- b) the following torque values shall apply:

| Torque value | Nominal screw thread diameter | |
|--------------|-------------------------------|---------------------|
| | Above | Up to and including |
| 0,2 Nm | — | 1,7 mm (0,067 in) |
| 0,3 Nm | 1,7 mm (0,067 in) | 2,2 mm (0,087 in) |
| 0,4 Nm | 2,2 mm (0,087 in) | 2,8 mm (0,110 in) |
| 0,5 Nm | 2,8 mm (0,110 in) | 3,0 mm (0,118 in) |
| 0,6 Nm | 3,0 mm (0,118 in) | 3,2 mm (0,126 in) |
| 0,8 Nm | 3,2 mm (0,126 in) | 3,6 mm (0,142 in) |
| 1,2 Nm | 3,6 mm (0,142 in) | 4,1 mm (0,162 in) |
| 1,8 Nm | 4,1 mm (0,162 in) | 4,7 mm (0,185 in) |
| 2,0 Nm | 4,7 mm (0,185 in) | 5,3 mm (0,209 in) |
| 2,5 Nm | 5,3 mm (0,209 in) | 6,0 mm (0,236 in) |
| 3,5 Nm | 6,0 mm (0,236 in) | 8,0 mm (0,315 in) |

- c) after the test, the switch shall be visually examined for broken, deformed, displaced or loose parts.

Requirement: after the test, there shall be no mechanical damage which would impair normal operation. Failure of the mounting screw is permissible.

4.8.4 Robustness of terminations

Method: the test shall be performed in accordance with IEC 512-8, Test 16f. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means;
- b) test Ua of IEC 68-2-21 shall apply to all terminals. Additional tests may be specified by the relevant specification;
- c) after the test, the switch shall be visually examined for broken, deformed, displaced or loose parts.

Requirement: after the test, there shall be no mechanical damage which would impair normal switch operation.

4.9 *Mechanical endurance*

4.9.1 *Mechanical endurance — Standard atmospheric conditions*

Object: to assess the proper mechanical functioning of the switch within a category temperature range of 0 °C to 55 °C through its rated mechanical life and for switches such as in-line switches which are not rated for actuation at extreme temperatures.

Method: the test shall be performed in accordance with IEC 512-5, Test 9a. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means;
- b) the number of cycles of operation and the frequency of actuation shall be specified by the relevant specification;
- c) after the test group sequence, the switch shall be subjected to the functional operation test (see 4.3.5) and the operating characteristics test (see 4.3.6). If applicable, the switch shall also be subjected to the specified tests for resistance measurements (see 4.4) and sealing (see 4.14 and 4.15).

Requirement: after the test, there shall be no damage which impairs the mechanical or electrical operation of the switch. When specified by the relevant specification, operating characteristics after the test may exceed the specified values by 20% maximum.

4.9.2 *Mechanical endurance — Category temperature range*

Object: to assess the proper mechanical functioning of the switch within its category temperature range through its rated mechanical life. This test applies when the switch has a category temperature range exceeding 0 °C to 55 °C.

Method: the test shall be performed in accordance with 4.9.1 except for the following details:

- a) one-half of the test samples shall be tested at the lower category temperature and the remaining half shall be tested at the upper category temperature.

Requirement: after the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10 *Electrical endurance*

4.10.1 *Electrical endurance — Standard atmospheric conditions*

Object: to assess the ability of the switch to control its rated power properly (above 6 V and 0,5 A) under electrical loads throughout its rated electrical life at standard atmospheric conditions.

Method: the test shall be performed in accordance with IEC 512-5, Test 9c. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means. When safety requirements must be met, the metal mounting plate and the metal test actuator shall be electrically grounded;
- b) the switch shall be tested for the number of cycles specified by the relevant specification;
- c) the frequency of actuation shall be specified by the sectional specification;
- d) the duty cycle for each electrical load shall be a minimum of 10% ON;
- e) switches previously tested for overload shall be tested using the same set of contacts which had been tested during overload (see 4.11.1);

- f) the switch shall be tested at the specified electrical load ratings which exceed 6 V and 0,5 A. Electrical endurance tests at the highest rated voltage may represent tests at a lower voltage of the same frequency if the volt-amperes at the lower voltage are not greater than the volt-amperes at the higher voltage. Electrical endurance tests on a.c. inductive loads may represent tests on a.c. resistive loads if the rated a.c. resistive current is not greater than the a.c. inductive current. For switches rated below 6 V or 0,5 A, tests in accordance with the logic loads (TTL) test (see 4.10.5) or with the low level test (see 4.10.6) may be selected;
- g) unless otherwise specified, the nominal frequency of the a.c. voltage shall be 50 Hz to 60 Hz;
- h) for double throw switches, half of the test samples shall be tested with the test load connected to the contacts of one throw and the remaining test samples shall be tested with the electrical load connected to the contacts of the other throw. For multiple pole switches, all poles shall be tested simultaneously;
- i) the power source shall have sufficient capacity to provide the required test current(s) after the closure of the switch while maintaining the required test voltage at the switch termination;
- j) unless otherwise specified, the switch shall be connected in the test circuit between the high side of the voltage source and the electrical load;
- k) a separate and independent electrical load shall be provided for each pole of the switch;
- l) when specified, the switch shall be continuously monitored to determine if any contact has failed to open (a "stick") or close (a "miss") its individual circuit in proper sequence. The monitoring circuit shall not shunt inductive components of the electrical load or the switch contacts. The monitoring device shall either provide a record of the switching action of the contacts or shall automatically stop the test if the switch fails to open or close the circuit. The maximum number of contact malfunctions shall be specified by the relevant specification.

The preferred values for requirements for sticks and/or misses are:

- 0 sticks or misses;
 - 1 stick or miss per 10^6 cycles;
 - 1 stick or miss per 10^5 cycles;
 - 1 stick or miss per 10^4 cycles;
 - 1 stick or miss per 1000 cycles;
 - 5 sticks and/or misses per 1000 cycles;
 - 10 sticks and/or misses per 1000 cycles;
 - no contact monitoring;
- m) the size of the connecting wire shall be appropriate to its rating;
 - n) after the test group sequence, the switch shall be subjected to the contact resistance — specified current test (4.4.2), the functional operation test (4.3.5) and the voltage proof test (4.5.1).

Requirement: when specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.2 *Electrical endurance — Upper category temperature*

Object: to assess the effect of the upper category temperature on the ability of the switch to control its rated power properly (above 6 V and 0,5 A) under electrical loads throughout its rated electrical life at standard atmospheric pressure.

Method: the test shall be performed as specified in 4.10.1 (electrical endurance — standard atmospheric conditions) except that during the test the switch shall be subjected to the upper category temperature specified for the switch.

Requirement: when specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.3 *Electrical endurance — Category temperature range*

Object: to assess the effect of the category temperature range on the ability of the switch to control its rated power properly (above 6 V and 0,5 A) under electrical load throughout its rated electrical life at standard atmospheric pressure.

Method: the test shall be performed as specified in 4.10.1 (electrical endurance — standard atmospheric conditions) except:

- a) during the test, the specified cycles of operation shall be performed at the following temperatures:
 - 80% at standard atmospheric conditions;
 - 10% at the lower category temperature;
 - 10% at the upper category temperature.

Requirement: when specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.4 *Electrical endurance — Low air pressure*

Object: to assess the effect of reduced air pressure on the ability of the switch to control its rated power properly (above 6 V and 0,5 A) under electrical loads throughout its rated electrical life.

Method: the test shall be performed as specified in 4.10.1 (electrical endurance — standard atmospheric conditions) except:

- a) during the test, the switch shall be subjected to a reduced air pressure equivalent to the altitude rating specified for the switch.

Requirement: when specified, the switch shall have no sticks and/or misses during the test in excess of those permitted. After the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.10.5 *Logic circuits*

Object: to assess the ability of the switch to properly control a specified logic level electrical load which exceeds the melting voltage of the contact material (approximately 0,4 V) and is less than the arcing voltage and arcing current (approximately 6 V and 0,5 A). The application circuit is presumed to buffer the initial 10 ms to exclude any contact bounce.

Method: the test shall be performed as follows:

- a) the switch shall be mounted by its normal mounting means;
- b) each pair of specimen contacts shall be tested using a $5 \pm 0,5$ V d.c., 10 ± 1 mA, resistive load. During each closure and each opening of each pair of contacts, the contacts shall be monitored with a device which does not alter the specified test parameters for the contacts. The monitoring device shall either record the proper opening and closing of the contacts, or shall discontinue the test in the event of a contact failure;
 - 1) monitoring during closure:
the contact voltage drop shall be monitored for no less than 50% of each contact static closure. The contacts shall not be monitored until 10 ms after the initial contact closure to exclude any contact bounce. A contact voltage drop of 2,1 V or greater shall constitute a contact “miss” (failure to close the circuit properly);

- 2) monitoring during opening:
the contact voltage drop shall be monitored for no less than 50% of each contact opening. The contacts shall not be monitored until 10 ms after the initial contact opening to exclude any contact bounce. A contact voltage drop less than 4,5 V shall constitute a contact "stick" (failure to open the circuit properly);
- c) the maximum number of contact malfunctions shall be specified by the relevant specification. The recommended values for requirements for sticks and/or misses are:
 - 0 sticks or misses;
 - 1 stick or miss per 10^6 cycles;
 - 1 stick or miss per 10^5 cycles;
- d) unless otherwise specified, the test shall be performed under standard atmospheric conditions;
- e) the number of cycles of operation shall be as specified by the relevant specification;
- f) the test voltage, test current and monitoring apply for TTL logic circuits only. Other values may be specified by the detail specification for other types of electronic logic circuits.

Requirement: during the test, the switch shall open and close each switching circuit in proper sequence.

4.10.6 Low level

Object: to assess the ability of the switch to properly control, throughout its rated life, a specified low level electrical load which is less than the softening voltage of the contact material (approximately 80 mV). The application circuit is presumed to buffer the initial 10 ms to exclude any contact bounce.

Method: the test shall be performed as follows:

- a) the switch shall be mounted by its normal mounting means;
 - b) each pair of specimen contacts shall be tested using a 20 mV maximum, 10 mA maximum, resistive load. During each closure and each opening of each pair of contacts, the contacts shall be monitored with a device which does not alter the specified test parameters for the contacts. The monitoring device shall either record the proper opening and closing of the contacts, or shall discontinue the test in the event of a contact failure;
- 1) monitoring during closure:
the contact voltage drop shall be monitored for no less than 50% of each contact static closure. The contacts shall not be monitored until 10 ms after the initial contact closure to exclude any contact bounce. A contact voltage drop of 50% of the open circuit voltage or greater shall constitute a contact "miss" (failure to close the circuit properly);
 - 2) monitoring during opening:
the contact voltage drop shall be monitored for no less than 50% of each contact opening. The contacts shall not be monitored until 10 ms after the initial contact opening to exclude any contact bounce. A contact voltage drop less than 90% of the open circuit voltage shall constitute a contact "stick" (failure to open the circuit properly);
- c) the maximum number of contact malfunctions shall be specified by the relevant specification. The preferred values for requirements for sticks and/or misses are:
 - 0 sticks or misses;
 - 1 stick or miss per 10^6 cycles;
 - 1 stick or miss per 10^5 cycles;
 - d) unless otherwise specified, the test shall be performed at standard atmospheric conditions;
 - e) the number of cycles of operation shall be as specified by the relevant specification.

Requirement: during the test, the switch shall open and close each switching circuit in proper sequence.

4.11 *Overload*

4.11.1 *Electrical overload*

Method: the test shall be performed in accordance with IEC 512-5, Test 10a. The following details shall apply:

a) the size of the connecting wire shall be appropriate to its rating.

Alternative method: the following method shall be used as an alternative method for assessing the performance of the switch under electrical overloads:

a) details a), c), d), g), h), i), j) and k) of the electrical endurance — standard atmospheric conditions test (4.10.1) shall apply;

b) the test shall be performed on the same contacts subjected to the tests in 4.10.1 to 4.10.4;

c) the switch shall be subjected to 50 cycles of operation;

d) the overload test current shall be:

— for current ratings of 10 A or less, the overload current shall be 150% of the current rating for the switch;

— for current ratings greater than 10 A, the overload current shall be 125% of the current rating for the switch;

e) the power factor for the test load shall be 0,70 to 0,80 for a.c. inductive ratings and 0,98 to 1 for a.c. resistive ratings;

f) during the test, the switch shall be continuously monitored to determine if any contact has failed to open or to close its individual circuit in proper sequence.

Requirement: during the test, the switch shall not fail to open or to close its individual switching circuits in proper sequence.

4.11.2 *Switching capacitive loads*

Object: to assess the making and breaking ability of a switch which is intended for use as a mains switch in accordance with IEC 65.

Method: the test shall be performed in accordance with IEC 512-5, Test 10c. The following details shall apply:

a) the switch shall be mounted by its normal mounting means;

b) the test shall be performed at rated voltage and at rated current;

c) after the test group sequence, the switch shall be subjected to the voltage proof test (see 4.5.1), except the test voltage shall be decreased to 500 V, and to the functional operation test (see 4.3.5).

Requirement: after the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.12 *Environmental*

4.12.1 *Climatic sequence*

Object: to assess the ability of non-heat-dissipating switches (temperature rise less than 5 °C) to withstand exposure to specified environments without degradation.

Method: the switch shall be tested in accordance with IEC 512-6, Test 11a. The following details shall apply:

a) for dry heat, the test shall be performed at the upper category temperature specified for the switch;

- b) for the first cycle of the cyclic damp heat test, the switch shall be tested with no electrical load. Temperature, variant and number of cycles shall be specified in the relevant specification;
- c) for cold, the switch shall be tested with no electrical load. The cold test shall be performed at the lower category temperature specified for the switch;
- d) for low air pressure, the test shall be performed in accordance with 4.5.2 (low air pressure). This portion of the climatic test is applicable only when an air pressure of less than 86 kPa is specified by the relevant specification;
- e) for the remaining cycles of cyclic damp heat, the switch shall be tested with no electrical load. Temperature, variant and number of cycles shall be specified in the relevant specification;
- f) after the test, the switch shall be visually examined for damage. After the test group sequence, the switch shall be subjected to the visual examination test (4.3.1), the functional operation test (4.3.5), the contact resistance — millivolt level test (4.4.1) or the contact resistance — specified current test (4.4.2), the insulation resistance test (4.4.4), the voltage proof test (4.5.1) and the operating characteristics test (4.3.6).

Requirement: after the test, there shall be no damage which impairs the normal operation of the switch.

4.12.2 *Damp heat, steady state*

Method: the test shall be performed in accordance with IEC 512-6, Test 11c.

Requirement: after the test, there shall be no damage which impairs the normal operation of the switch.

4.12.3 *Rapid change of temperature*

Method: the test shall be performed in accordance with IEC 512-6, Test 11d. The following details shall apply:

- a) the test shall be performed without an electrical load;
- b) the low temperature shall be the lower category temperature;
- c) the high temperature shall be the upper category temperature;
- d) five cycles shall be performed;
- e) the duration of each exposure shall be 30 min;
- f) the duration of the change-over time shall be 3 min maximum;
- g) after the test, the switch shall be visually examined for damage. After the test sequence, the switch shall be subjected to the functional operation test (see 4.3.5).

Requirement: after the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.12.4 *Mould growth (resistance)*

Object: to assess the extent of mould growth by a short exposure of 28 days to determine whether resistant materials have been used.

Method: the test shall be performed in accordance with IEC 512-6, Test 11e. The test variant shall be specified by the relevant specification. The following details shall apply:

- a) the test shall be performed on representative samples of the insulating materials;
- b) the duration of the test shall be 28 days;
- c) after the test, the specimen shall be visually examined for mould growth.

Alternative method: the insulating materials used to produce the piece parts shall have been previously assessed for vulnerability to damage by mould contamination using established mycological testing procedures.

Requirement: after the test, the extent of mould growth shall be assessed as either 0 or 1 unless otherwise specified.

4.12.5 *Corrosion, industrial atmosphere*

Object: to assess by an accelerated means the corrosive effects on the switch of an atmosphere polluted with sulphur dioxide and/or hydrogen sulphide.

No requirements have been established at the present time.

4.12.6 *Sand and dust (see note)*

Object: to assess the ability of the switch to withstand the effects of a dry, sand and dust-laden atmosphere.

NOTE — This test is provisional pending the results of work in progress.

Test equipment: the test facility shall consist of a chamber and accessories to control dust concentration, velocity, temperature and humidity of dust laden air. In order to provide adequate circulation of the dust laden air, no more than 50% of the cross-sectional area (normal to air flow) and 30% of the volume of the chamber shall be occupied by the test item(s). The chamber shall be provided with a suitable means of maintaining and verifying the dust concentration in circulation. A minimum acceptable means for doing this is by use of a properly calibrated smoke meter and a standard light source. The dust laden air shall be introduced into the test space in such a manner as to allow it to become approximately laminar in flow before it strikes the test sample.

Test medium: the dust used in this test shall be a fine sand (97-99% by weight SiO_2) of angular structure and shall have the following size distribution as determined by weight:

- a) 100% of the dust shall pass through a 100-mesh (150 μm) screen;
- b) $98 \pm 2\%$ of the dust shall pass through a 140-mesh (106 μm) screen;
- c) $90 \pm 2\%$ of the dust shall pass through a 200-mesh (75 μm) screen;
- d) $75 \pm 2\%$ of the dust shall pass through a 325-mesh (45 μm) screen.

Method: for switches which are intended to be mounted through the wall of an enclosure or panel, the switch shall be mounted by its normal mounting means through the wall of an enclosure which is adequately sealed to prevent the ingress of the test medium.

Place the test sample in the chamber as near the centre of the chamber as practicable. If more than one sample is being tested, there shall be a minimum clearance of 100 mm (4 in) between surfaces of test samples or any other object capable of furnishing protection. Also, no surface of the test sample shall be closer than 100 mm (4 in) from any wall of the test chamber. Orient the item so as to expose the most critical or vulnerable parts to the dust stream. The test sample orientation may be changed during the test if so required by the detail specification.

Step 1 — Set the chamber controls to maintain an internal chamber temperature of 23 °C (73 °F) and a relative humidity of less than 22%. Adjust the air velocity to $8,89 \pm 1,27$ m/s (1750 ± 250 ft/min). Adjust the dust feeder to control the dust concentration at $10,7$ g/m³ (0,3 g/ft³). Maintain these conditions for 6 h. The switch shall be operated for 50 cycles once every hour.

Step 2 — Stop the dust feed and reduce the air velocity to $1,54 \pm 1,02$ m/s (300 ± 200 ft/min). Raise the internal chamber air temperature to 63 °C (145 °F) and adjust humidity control to maintain a relative humidity of less than 10%. Hold these conditions until the temperature and humidity stabilize.

Step 3 — While holding chamber temperature at 63 °C (145 °F), adjust the air velocity to $8,89 \pm 1,27$ m/s (1750 ± 250 ft/min), and maintain a relative humidity of less than 10%. Adjust the dust feeder to control the dust concentration at $10,7$ g/m³ ($0,3$ g/ft³). Maintain these conditions for 6 h. The switch shall be operated for 50 cycles once every hour.

Step 4 — Turn off all chamber controls and allow the test item to return to standard atmospheric conditions. Remove accumulated dust from the test item by brushing, wiping or shaking, care being taken to avoid introduction of additional dust into the test item. Under no circumstances shall dust be removed by either air blast or vacuum cleaning.

Post-test requirements: after the test, the switch shall be subjected to the operating characteristics test (see 4.3.6).

Requirement: after the test, there shall be no damage which impairs the mechanical or electrical operation of the switch.

4.12.7 *Contact resistance stability*

Object: to assess the effects of ageing on the stability of the contact resistance of the switch contacts which may occur when there is an extended period of time between switch actuations. The effects of ageing are simulated by the long term exposure to the upper category temperature. This test is normally considered applicable to switches used at source voltages not exceeding the mV level and has an extended period of time between actuations.

Method: the switch shall be tested in accordance with the following:

- a) preconditioning: the switch shall be tested in accordance with IEC 512-5, Test 9a. The following details shall apply:
 - 1) the switch shall be mounted by its normal mounting means;
 - 2) the number of cycles of operation shall be 10% of the rated mechanical operations unless otherwise specified by the relevant specification;
 - 3) the frequency of actuation shall be specified by the relevant specification;
- b) conditioning: the switch shall be tested in accordance with IEC 512-6, Test 11i. The following details shall apply:
 - 1) degree of severity: the temperature during the test shall be the upper category temperature specified for the switch. The duration of exposure shall be 100, 200, 500, 1000 or 2000 h as specified by the relevant specification;
 - 2) when necessary, the relevant specification shall specify special conditions to ensure that the conditioning is applied to both open switch contacts and closed switch contacts;
 - 3) during the temperature exposure, closed switch contacts shall not be disturbed. The switch shall not be actuated nor subjected to any significant dynamic stresses such as vibration or shock;
- c) final measurements: after conditioning and prior to the final measurement, closed switch contacts shall not be disturbed by either switch actuation or by dynamic stresses. After the test, all closed switch contacts shall be measured in accordance with 4.4.1 (contact resistance — millivolt level). Then the switch shall be actuated as required to close the switch contacts which were open during the conditioning, and then all closed contacts shall be measured in accordance with 4.4.1 (contact resistance — millivolt level).

Requirement: after the test, the contact resistance shall be within the limits specified by the relevant specification.

4.13 *Soldering*

4.13.1 *Solderability*

Method: the test shall be performed in accordance with IEC 512-6, Test 12a. The following details shall apply:

- a) method 1 (solder bath at 235 °C) shall apply. When Method 1 is impractical due to the configuration of the switch, either the terminal shall be tested as a piece part if the finish has been applied or Test 12b, Method 2 (soldering iron at 350 °C) of IEC 512-6 shall apply;
- b) ageing 1a (1 h steam) as per 4.5.1 of IEC 68-2-20 shall apply;
- c) the terminals shall be immersed to within 1,5 mm (0,059 in) of the switch body unless otherwise specified;
- d) switch terminals intended for mounting on a printed board shall, unless otherwise specified in the detail specification, be tested with the thermally insulating screen specified in IEC 68-2-20;
- e) after the test, the terminals shall be examined using 10 power magnification.

Requirement: after the test, the solderable surface of the dipped terminal shall be 95% covered with a smooth, bright solder coating. Any pinholes or voids shall not exceed 5% of the dipped area and shall not be concentrated in one area.

4.13.2 *Solderability, wetting, iron method*

Method: the test shall be performed in accordance with IEC 512-6, Test 12b. The following details shall apply:

- a) ageing 1a (1 h steam) as per 4.5.1 of IEC 68-2-20 shall apply.

Requirement: the solder shall wet the terminal and there shall be no droplets formed on the terminal.

4.13.3 *Solderability, dewetting*

Method: the test shall be performed in accordance with IEC 512-6, Test 12c.

Requirement: the solderable surface of the dipped terminal shall be 95% covered with a smooth, bright solder coating. Any imperfections (dewetted areas) shall not be concentrated in one area.

4.13.4 *Resistance to soldering heat, solder bath method*

Method: the test shall be performed in accordance with IEC 512-6, Test 12d.

Requirement: there shall be no damage that would impair normal operation.

4.14 *Panel seal*

Switches which are mounted into a cutout in a panel or in the wall of an enclosure may be required to provide a seal to prevent the penetration of liquid. The panel seal tests provide a means of assessing the capability of the switch to maintain the category of sealing required for the panel or enclosure. The panel seal tests provide no assessment of the sealing, if any, of the switching mechanism.

4.14.1 *Drip-proof*

Object: to assess the ability of the switch panel seal to protect an enclosure against dripping water when tilted up to 15°.

Method: the test shall be performed in accordance with IEC 529 for designation IP 02. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means to a panel;
- b) the test shall be performed on the front face of the panel.

Requirement: during the test, no water shall ingress through the panel seals of the switch.

4.14.2 *Splashproof*

Object: to assess the ability of the switch panel seal to prevent water penetration into an enclosure when it is subjected to spraying or splashing water.

Method: the test shall be performed in accordance with IEC 529 for designation IP 04. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means to a panel;
- b) the test shall be performed on the front face of the panel.

Requirement: during the test, no water shall ingress through the panel seals of the switch.

4.14.3 *Immersion*

Object: to assess the ability of the switch panel seal to prevent water penetration into an enclosure when it is immersed in water.

Method: the test shall be performed in accordance with IEC 529 for designation IP 07. The following details shall apply:

- a) the switch shall be mounted by its normal mounting means in the wall of the enclosure for the water;
- b) the switch panel seals shall be at least 1 m below the surface of the water;
- c) switches with dynamic seals shall be subjected to 25 cycles of operation;
- d) after the test, the body of the enclosed switches shall be opened to check for leakage into the switch body;
- e) as an alternative, the switch may be subjected to the submersion test (see 4.14.4) at an air pressure of $10 \pm 0,5$ kPa.

Requirement: during the test, no water shall ingress through the panel seals of the switch.

4.14.4 *Submersion*

Object: to assess the ability of the switch panel seal to prevent water penetration into an enclosure when it is submerged in water.

Method: the test shall be performed in accordance with IEC 529 for designation IP 08. The following details shall apply:

- a) prior to mounting, panel seals which are readily removable shall be removed from the switch and then reassembled;

- b) the switch shall be mounted in the side of a test chamber as indicated in Figure 4, below, by its normal mounting means. The test chamber shall be adequately sealed to withstand the test pressure without leakage. The test chamber shall be capable of applying, regulating, maintaining and measuring the required air pressure. The test chamber shall have a means of actuating the test switch from either the front, the side or the rear of the switch. Figure 4 illustrates a typical test chamber;
- c) the test chamber shall be filled with fresh tap water to a level of 150 ± 50 mm above the switch. The internal pressure of the test chamber shall then be gradually increased at an approximate rate of 1 kPa per minute until the required air pressure is attained;
- d) the difference between the air pressure in the test chamber and the external air pressure shall be 105 ± 5 kPa unless otherwise specified. If otherwise specified, the following values are recommended:
- $10 \pm 0,5$ kPa
 - 20 ± 1 kPa
 - 45 ± 1 kPa
 - 350 ± 10 kPa
- e) the specified pressure differential shall be maintained for 30 min. During this period, switches with dynamic seals shall be actuated for 25 cycles;
- f) after the test, the body of enclosed switches shall be opened to check for leakage.

Requirement: during the test, no water shall ingress through the panel seals of the switch.

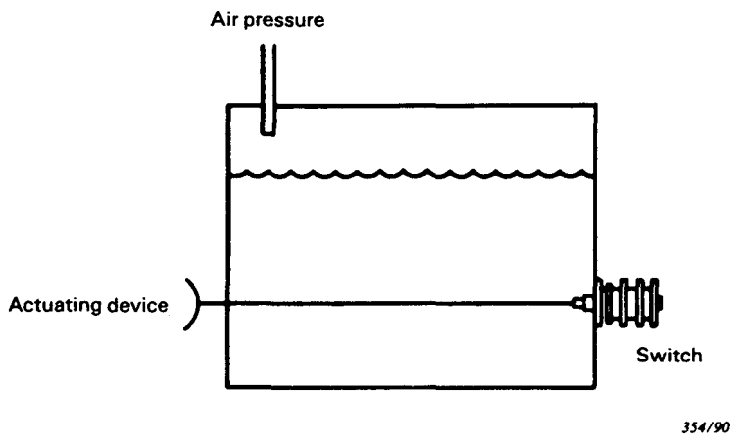


Figure 4 — Submersion seal test enclosure

4.15 Enclosure seal

To protect the switch contacts and the switching mechanism, a switch may have an enclosure which is sealed to prevent the penetration of contamination or moisture, or to maintain a constant internal pressure. The enclosure seal tests provide a means of assessing the capability of the switch enclosure to provide a prescribed category of sealing.

4.15.1 Watertight immersion

Object: to assess the ability of the switch enclosure to protect the internal mechanism during immersion in water.

Method: the test shall be performed in accordance with IEC 68-2-17, Test Qf. The following details shall apply:

- a) the test shall be performed at a pressure difference of 14,7 kPa or at a 1,50 m head of water;
- b) the duration of the test shall be 10 min for qualification approval tests and 1 min for quality conformance tests;
- c) a steady stream of air bubbles emanating from within the switch shall constitute failure. Air bubbles which are the result of entrapped air on the surface of the switch are permissible;
- d) after qualification approval tests, the switch shall be opened and examined for ingress of water.

Requirement: during the test, a steady stream of air bubbles emanating from within the switch is not permissible. When opened after the test, no water shall have ingressed into the switch enclosure.

4.15.2 *Resilient or hermetic seal*

Object: to assess the ability of the switch enclosure to protect the internal switching mechanism from the ingress of gases by means of resilient or hermetic seals.

Method: the test shall be performed in accordance with IEC 68-2-17, Test Qk. The following details and exceptions shall apply:

- a) a mass-spectrometer leak detector shall be connected to the internal switching cavity by any suitable means, such as an evacuation tube, and a vacuum created inside the switch. The switch shall then be subjected to a helium atmosphere by surrounding the switch with helium. If a defect exists in the switch, an amount of gas that depends upon the size of the defect will be drawn through the defect and pass into the leak detector for measurement;
- b) after the test, the switch will be filled with dry air or a known gas. The connection to the internal switching cavity shall be removed and the entrance sealed by suitable means, such as soldering or welding. The switch shall then be checked for gross leaks using the watertight immersion test (see 4.15.1).

Requirement: during the test, the leakage rate shall not exceed 1×10^{-4} kPa cm³/s (1×10^{-6} atm cc/s) for resilient seals or 1×10^{-6} kPa cm³/s (1×10^{-8} atm cc/s) for hermetic seals.

4.16 *Fluid resistance*

4.16.1 *Immersion in cleaning solvents (marking)*

Object: to assess the ability of the marking on switches intended for mounting on printed circuit boards to withstand the detrimental effects of cleaning solvents.

Method: the test shall be performed in accordance with IEC 68-2-45, Test XA. The following details shall apply:

- a) the detail specification shall specify the solvent(s) to be used. When specified, separate test specimens shall be used for each solvent;
- b) unless otherwise specified, the temperature of the solvent shall be 23 °C to 28 °C;
- c) unless otherwise specified, conditioning Method 1 shall apply;
- d) rub with cotton wool;
- e) after the test, the marking shall be visually examined.

Requirement: after the test, the marking shall be legible.

4.17 *Fire hazard*

4.17.1 *Flammability**

Object: to assess the flammability of the switch when exposed to an igniting source.

Method: the insulating materials used for the support of current-carrying parts and for the external switch parts shall be tested in accordance with IEC 707. The following details shall apply:

a) the test method shall be BH, FH or FV.

Requirement: the materials shall be categorized as BH1, BH2, FH1, FH2, FV0, FV1 or FV2.

4.18 *Capacitance*

4.18.1 *Capacitance*

Method: the test shall be performed in accordance with IEC 512-9, Test 22a. The following details shall apply:

a) the measurement shall be performed between individual terminations which form part of a switching circuit but are not electrically connected, and one termination and all other terminations which are connected to the frame or to grounded metal parts.

Requirement: the capacitance shall be within the limits specified by the relevant specification.

4.19 *Illumination*

4.19.1 *Chromaticity*

Object: to assess the colour of the light emanating from the incandescent display of an illuminated switch.

Method: the test shall be performed in accordance with one of the following methods.

- a) **spectrophotometer: flat slab:** the chromaticity shall be measured using a spectrophotometer, a flat slab of material which has the same density and thickness as the shaped filter, and the necessary calibration filters;
- b) **spectroradiometric:** the chromaticity shall be measured using a spectroradiometer, an illuminated switch, calibrated lamps of specified colour temperature and the necessary calibration filters;
- c) **visual comparator:** the chromaticity shall be determined to be within specified limits by a colour comparator, the necessary high and low limit filters of known chromaticity and calibrated light sources of the specific colour temperature.

Requirement: the chromaticity of each colour shall be within the limits specified by the relevant specification.

4.19.2 *Transmittancy*

Object: to assess the amount of light transmitted through the translucent display of an illuminated switch.

Method: the test shall be performed in accordance with one of the following methods:

- a) **photometric:** the measurement shall be performed in completely dark surroundings using a calibrated photoelectric photometer. All readings shall be point readings and shall be averaged. Luminance measurements may be performed without the legend inserted if the legend material is not a significant part of the illumination system. The number and location of the point readings shall be specified by the relevant specification;

* This test is provisional pending the related decisions of TC 12 and TC 89 with regard to the basic safety standards for fire hazards and of TC 48 with regard to IEC 512-9, Test 20a.

b) colorimeter: the measurement shall be performed with a colorimeter by spectrophotometric analysis.

Requirement: the transmittancy shall be within the limits specified by the relevant specification.

4.19.3 *Temperature of illuminated surface*

Object: to assess the temperature on the accessible surface of an illuminated display.

Method: the test shall be performed in accordance with the following:

- a) the switch shall be mounted by its normal mounting and oriented so that the illumination source is vertically below the illuminated surface;
- b) each illumination source shall be operated at its maximum rated voltage;
- c) each pole of the switch shall carry its maximum rated current;
- d) after two hours, the temperature in the centre of the display shall be measured by means of a small contact probe or thermocouple;
- e) the test shall be performed in still air.

Requirement: the temperature rise shall be within the limits specified by the relevant specification.

(Continued from second cover)

| <i>International Standards</i> | <i>Corresponding Indian Standard</i> | <i>Degree of Equivalence</i> |
|---|--|------------------------------|
| IEC Pub 512-6 (1984) Electromechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 6 : Climatic tests and soldering tests | IS 12448 (Part 6) : 1991 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 6 Climatic tests and soldering tests | Equivalent |
| IEC Pub 512-7 (1978) Electro-mechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 7 : Mechanical operating tests — Sealing tests Amendment No. 1 (1983) | IS 12448 (Part 7) : 1991 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 7 Mechanical operating tests — Sealing tests Amendment No. 1 | Equivalent |
| IEC Pub 512-8 (1984) Electromechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 8 : Connector tests (mechanical) and mechanical tests on contacts and terminations Amendment No. 1 (1985) | IS 12448 (Part 8) : 1992 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 8 Connector tests (mechanical) and mechanical tests on contacts and terminations Amendment No. 1 | Equivalent |
| IEC Pub 512-9 (1977) Electro-mechanical components for electronic equipment: Basic testing procedures and measuring methods. Part 9 : Cable-clamping tests, explosion hazard tests, chemical resistance tests, fire hazard tests, r.f. resistance tests, capacitance tests, shielding and filtering tests and magnetic interference tests Amendment No. 1 (1982) | IS 12448 (Part 9) : 1992 Basic testing procedures and measuring methods for electromechanical components for electronic equipment: Part 9 Cable-clamping tests, explosion hazard tests, chemical resistance tests, fire hazard tests, r.f. resistance tests, capacitance tests, shielding and filtering tests and magnetic interference tests Amendment No. 1 | Equivalent |
| IEC Pub QC 001001 : (1981) Basic rules of the IEC quality assessment system for electronic components (IECQ) | IS QC 001001 : 1988 Basic rules of the IEC quality assessment system for electronic components (IECQ) | Identical |
| IEC Pub QC 001002 : (1981) Rules of procedure of the IEC quality assessment system for electronic components (IECQ) | IS QC 001002 : 1988 Rules of procedure of the IEC quality assessment system for electronic components (IECQ) | Identical |

The concerned technical committee has reviewed the provisions of IEC 27, IEC 50 (581), IEC 62, IEC 65, IEC 68-1(1983), IEC 68-2-17 (1978), IEC 68-2-20 (1979), IEC 68-2-21 (1983), IEC 68-2-38 (1974), IEC 68-2-45 (1980), IEC 410 (1973), IEC 617, IEC 664, IEC 664A, IEC 707 (1981), ISO 129, ISO 286-1, ISO 1000 and ISO 1101, referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard.

This standard is intended primarily for use under the IECQ System. A regular Indian Standard for this component could be different, identical or similar to this standard.

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.